

Descriptions of four new species of the genus *Gibberula* Swainson, 1840 (Gastropoda: Cystiscidae) from the western Caribbean Sea and proposal for a new species group

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ABSTRACT. Four new species of *Gibberula* from the western Caribbean Sea are described for the first time, all considered to belong to the proposed *G. ubitaensis* species group. *G. farlensis* is described from Belize; *G. ubitalta*, *G. crassa* and *G. macula*, from eastern Panama. The four new species are compared with all known Caribbean *Gibberula* species with very high labial insertion, and variations in their shell morphology and animal chromatism are presented. The proposed *G. ubitaensis* species group is commented upon, details of diagnostic features are given and species belonging to the group are listed.

INTRODUCTION

During sampling by the author in Islas Rosario, Colombia, in 1998, two specimens of an undescribed *Gibberula* species were collected amongst weed covered rubble in shallow water. It was noticed that these specimens had an unusual spire and suture for the genus, and these features are now recognised as diagnostic of *Gibberula ubitaensis* species group. This species was later collected in Costa Rica and described as *Gibberula ubitaensis* Espinosa and Ortea, 2000, (Avicennia, 12-13, 2000, pp. 97-99), and is taken as reference species for the proposed *Gibberula ubitaensis* species group. This species group is only found in the western Caribbean where it is widespread and common.

During the past ten years there has been an increasing number of new Caribbean *Gibberula* species described. In the year 2000 the number described stood at only five and this has now grown to more than forty. Many of these new species are from eastern Costa Rica and Cuba, and have been described by Espinosa and Ortea, (Avicennia, 12-13, 2000, pp. 95-114), (Avicennia, 18, 2005, pp 36-42), and (Avicennia, 19, 2007, pp 99-120). Three of these species appear to be very closely related to each other and have the very distinct spire morphology which is only found in *Gibberula* with very high labial insertion from the western Caribbean: *G. ubitaensis* from Costa Rica, *G. hiramii* and *G. baisrei* from Cuba. A further two species appear to be less closely related to these three, but also have the same distinctive spire morphology and very high labial insertion: *G. sierrai* from Costa Rica, and *G. olivai* from Cuba. All are considered to belong to *G. ubitaensis* species group and are commented upon herein.

Amongst material collected in the western Caribbean by the author in recent years were four undescribed species also with the same distinct spire morphology: *G. farlensis* from Belize; *G. ubitalta*, *G. crassa* and *G. macula*, from eastern Panama. These new species are described in this article, and the distinct spire morphology which links them to *G. ubitaensis* species group is commented upon in detail.

METHODS AND MATERIALS

As far as possible digital images of all shells and live animals of new species described herein have been figured in the plates. Images are reproduced at approximately X20 magnification, unless otherwise stated. Selected images of spires and sutures have been figured, sized to approximately 3.6 mm height, with varying magnifications.

Some repetitive diagnostic features of the genus are not repeated in descriptions. These include 'external varix is absent', 'anterior notch present', 'posterior notch present', 'Type 4 animal', 'mantle not usually extending over external shell surface'. Where the term 'semi-transparent' is applied to the shell, this refers to live specimens - once animals die shells quickly become translucent white or opaque, and subsequently hyaline.

Assessment of foot length of live animals is subjective - in their natural habitat external parts are normally fully extended, but in the aquarium when being photographed this is not often the case. Live animals are photographed in dorsal view, therefore, dorsal views of dried shells have only been featured where live animal images were not available.

Hand dredging in sand or muddy substrates and the use of a hand operated suction pump on rocks and

rubble substrates were the most productive methods of collecting *Gibberula* in shallow waters to approximately 30 metres deep. Night diving yielded some positive results as specimens could be picked up from sand and rubble, or off rocks. Many species were collected by dredging from the author's yacht "Marina Em" with the aid of a small hydraulically operated reel. The resultant grit from all methods of collection was screened into four grades. Finer grades were placed in a bowl of sea water and covered. Live animals then crawled up the sides where they could be picked up. Finer grades of grit from deep dredging were also sorted visually for dead shells, which comprised on average approximately 98 percent of all shells collected by this method.

Samples from live material were photographed in a small aquarium below a microscope with digital camera mounted on top. The same equipment was used for detailed imaging of dried shells. The system, was calibrated so that shell dimensions could be obtained from data displayed by software, and shell dimensions are believed to be accurate to plus or minus 3%. A comparator was used for comparing two or more shell images. This was very useful in highlighting small morphological differences which are otherwise almost impossible to detect.

Some shells have been sectioned to enable imaging of internal features, such as partially re-absorbed internal whorls and morphology of sutures which on occasions are not visible externally.



Map 1. Caribbean Sea, type localities of new species and other locations

Key to map location numbers.

1. Belize, Farl's Bogue, 17°25.73'N 88°04.10'W.
2. Costa Rica, Punta Ubita and Punta Mona, Manzanillo, 9°48'W 82°50'W approx.
3. Panama, Bocas del Toro, 9°21'N 82°14'W.
4. Panama, Isla Escudo de Veraguas, 9°06'N 81°33.5'W.
5. Panama, Isla Linton 9°37'N 79°33.5'W, and off Linton, 9°41.6'N 079°37.5'W.
6. Panama, Playa Damas, 9°35.5'N 79°28'W.
7. Panama, Escribanos reefs, 9°39.4'N 79°09.7'W.
8. Panama, Neloguichi. San Blas, 9°32.314'N 79°02.255'W.

9. Panama, off Cichime Cays, San Blas, 9°37.3'N 78°52.4'W, Lemon Cays, San Blas, 9°32.1'N 78°53.9'W, east Holandes Cays, 9°34.7'N 78°41.3'W.
10. Panama, Snug Harbour, San Blas, 9°19.7'N 78°15.1'W, off Playon Chica 9°23.0'N 78°09.5'W.
11. Colombia, Islas Bernardo, 9°47'N 75°51'W.
12. Colombia, Islas Rosario, 10°11'N 75°45'W.
13. Colombia, off Cartagena, 10°23'N 75°39'W.
14. Belize, Lighthouse reef, 17°18'N 87°30'W.
15. Colombia, Isla Providencia, 12°18'N 82°59'W.
16. Colombia, Isla San Andreas, 12°10'N 83°02'W.
17. Venezuela, off Islas Los Testigos, 11°27'N 63°06'W.
18. Cuba, Pinar del Rio, 22°N 84°W approx.

Abbreviations

MNHN: Muséum national d'Histoire naturelle, Paris, France.

AWC: Andrew Wakefield Collection.

TMC: Tony McCleery Collection.

ad.: adult specimen.

dd.: dead collected.

lv.: live collected.

juv.: juvenile specimen.

L.: shell length.

W.: shell width.

The author has, in general, followed terminology established by Coovert and Coovert (1995).

SYSTEMATICS

Family **CYSTISCIDAE** Stimpson, 1865.

Subfamily **PERSICULINAE** Coovert and Coovert, 1995.

Genus *Gibberula* Swainson, 1840.

Type species. *G. zonata* Swainson, 1840, = *Volvaria oryza* Lamarck, 1822, by monotypy.

Gibberula farlensis n. sp.

Figs. 12-14, 46

Type material. Belize. Farl's Bogue, 17°25.73'N 88°04.10'W, near mangroves, 2 m, weedy mud. Holotype. 2.26 x 1.47 mm, W:L 65%, ad. lv., MNHN 20976; Paratype 1. 2.26 x 1.46 mm, W:L 65%, ad. lv., MNHN 20977; Paratype 2. 2.37 x 1.50 mm, W:L 63%, ad. lv., TMC; Paratype 3. 2.02 x 1.29 mm, W:L 64%, ad. lv., TMC.

Other material. 6 juv. lv., Belize. Farl's Bogue, 17°25' 73' N 88°04' 10' W, near mangroves, 2 m, weedy mud.

Type locality. Belize. Farl's Bogue, 17°25.73'N 88°04.10'W (Map ref. 1).

Description. Shell smooth, glossy, semi-transparent, ovate, size range 2.02 x 1.29 mm to 2.37 x 1.50 mm. W:L 64-65%. spire very low, apex rounded. callused over, transparent. Protoconch embedded, invisible. Teleoconch suture slightly less than one turn, visible beneath callus, emerges from protoconch, drops down abruptly anteriorly, progresses horizontally for half revolution, drops down anteriorly over preceding whorl for further quarter revolution before sweeping up to insertion point, callused over. Lip almost straight, thickened, slightly raised and curled inwards posteriorly, flared anteriorly, 6 labial denticles almost fill anterior half, posterior notch weak, shoulder very weak and rounded. Three columellar plications and two lirae fill half of aperture. First and second strong, third weak, lirae very weak. Anterior callus strong at

distal ends of first and second plication, weak at third. Moderate parietal callus ridge present. Aperture moderately wide, widening slightly anteriorly. Animal: foot approximately 50% longer, slightly wider than shell, semi-transparent, 5 strong white marks laterally, random smaller white marks between, two stronger ones extending posteriorly, stronger marks extend almost to edge of foot, some dull round orange spots intermingled with small black marks between white marks. Lobes of semi-transparent split head with white marks medially, black marks and two orange spots distally. Tentacles semi-transparent, unmarked. Eyes black with faint greyish annular rings. Siphon short, opaque yellowish-white with some orange marks. Mantle roof comprised of white background appearing as numerous small irregularly shaped areas, numerous round orange spots and contiguous black and green marks predominantly at sides. Pale narrow band immediately anterior to suture, green colour absent. All colours are present in chromatism above suture, this area being dominated by two large, round, white spots adjacent to suture.

Distribution. Only known from type locality.

Habitat. Farl's Bogue is one of a number of similar navigable channels between numerous mangrove islands which separate the outer reef flats from the very large lagoon, off Belize City. Strong currents run in these channels, but smaller channels penetrate the mangroves and are without tidal current. *G. farlensis* n. sp. was collected in such a channel, close to mangroves. Depth was 2 metres, and substrate was brownish mud with weed and mangrove debris.

Remarks. *Gibberula farlensis* n. sp. is closest to *G. ubitaensis* Espinosa and Ortea, 2000, (Figs. 1-19, 36, 41-43, 45, 47, 48) with which it is compared. The main difference is the chromatism in which the pattern is significantly more variegated and has considerably more black areas than seen in any specimens of *G. ubitaensis*. Other differences are the labial insertion point is slightly lower, the posterior end of the shell is evenly rounded giving a more ovate shape to the shell, the lip is almost straight, and the columellar plications and labial denticles are equally as strong as any seen within the wide range of variations found in *G. ubitaensis*. Habitat where *G. farlensis* n. sp. was collected was amongst mangroves and the substrate was substantially brownish mud, whereas *G. ubitaensis* is restricted to weed, algae, sand, or mud covered surface areas of rocks and rubble, occasionally in mangrove areas. *G. ubitaensis* was collected in a number of locations in Belize, but *G. farlensis* n. sp. was only found in Farl's Bogue where it is considered to be endemic.

Etymology. The name is taken from the type locality.

Gibberula ubitalta n. sp.

Figs. 11, 15, 53

Type material. Off Chichime Cays, San Blas, Panama, 9°37.3'N 78°52.4'W, 73-75 m. Holotype. 2.50 x 1.60 mm, W:L 64%, ad. lv., MNHN 20978; Paratype 1. 2.58 x 1.61 mm, W:L 62%, ad. dd., MNHN 20979; Paratype 2. 2.10 x 1.50 mm, W:L 64%, ad. dd., TMC; Paratype 3. 2.59 x 1.66 mm, W:L 64%, ad. lv., AWC; Paratype 4. 2.51 x 1.63 mm, W:L 65%, ad. dd., AWC; Paratype 5. 2.87 x 1.74 mm, W:L 61%, juv. dd., TMC.

Other material. 1 juv. lv., 2 ad. dd., off Chichime Cays, San Blas, Panama, 9°37.3'N 78°52.4'W, 75 m.

Type locality. Off Chichime Cays, San Blas, Panama, 9°37.3'N 78°52.4'W, 75 m (Map ref. 9).

Description: Shell smooth, glossy, semi-transparent, obovate, size range 2.10 x 1.50 mm to 2.87 x 1.74 mm, W:L 61-65%. Spire very low, apex rounded, callused over, transparent. Protoconch embedded, invisible. Teleoconch suture slightly less than one turn, visible beneath callus, emerges from protoconch, drops down abruptly anteriorly, progresses horizontally for half revolution, drops down anteriorly over preceding whorl for further quarter revolution before sweeping up to insertion point, level with apex, callused over. Lip slightly curved, thickened, slightly raised, curled inwards posterior medially, flared anteriorly, labial denticles very weak, posterior notch

weak, shoulder moderately strong. Three columellar plications and two lirae fill less than half of aperture. First and second strong, third weak, lirae very weak. Anterior callus strong at distal ends of first and second plication, weak at third. Moderately strong parietal callus ridge present. Aperture moderately wide, widening slightly posteriorly, more so anteriorly. Animal: length of foot not determined, slightly wider than shell, semi-transparent, 5 strong white marks laterally, small white marks together with orange spots and small black marks between, two stronger white marks extend posteriorly with numerous orange spots and some small irregular black marks between, marks extend almost to edge of foot. Lobes of semi-transparent split head with white marks medially, black marks and orange spots distally, not reaching edge. Tentacles semi-transparent with one orange mark. Eyes black with faint greyish annular rings, tinged with orange anteriorly. Siphon short, opaque yellowish-white with pale orange spots. Mantle roof: yellowish-white background appears around extensive green areas covered with many irregular shaped orange marks finely edged with black. Chromatism is strong posterior medially and in right quarter where a distinct mark is located, green in centre surrounded by orange marks, all outlined in black. Green with orange marks is present in area above the suture, two large semi-circular yellowish white marks located on posterior edge of suture. The most salient feature of chromatism is the irregular shape of the orange marks.

Distribution. Only known from type locality.

Figures 1-20

Figures 1-10. *Gibberula ubitaensis* Espinosa and Ortea, 2000. Images showing variations found across the geographic distribution range.

1, 6. Specimen most closely resembling type species, Isla Escudo de Veraguas, Panama, 2.36 x 1.53 mm, W:L 65%; **2.** Heavy, inflated shell and strong columellar plications, Isla Providencia, Colombia, (mag. X17), 2.56 x 1.75 mm, W:L 68%; **3.** Small specimen with typical columellar plications, weak labial denticles, very light callus, Isla Linton, Panama, 2.02 x 1.30 mm, W:L 65%; **4.** Pale chromatism, typical columellar plications, very weak labial denticles, weak callus, inflated shell, Islas Rosario, Colombia, 2.13 x 1.46 mm, W:L 69%; **5.** Strong columellar plications and labial denticulation, inflated, Sandfly Bay, Bocas del Toro, Panama, 2.54 x 1.72 mm, W:L 68%; **7.** Dark chromatism with contrasting white areas, Playa Damas, Panama, 1.94 x 1.27 mm, W:L 66%; **8.** Pale chromatism, Islas Bernardo, Colombia, 2.31 x 1.53 mm, W:L 66%; **9.** Specimen from mangrove lagoon, Neloguichi, San Blas, Panama, 2.03 x 1.37 mm, W:L 68%; **10.** Unusual reddish chromatism, Isla San Andres, Colombia, 2.27 x 1.51 mm, W:L 67%.

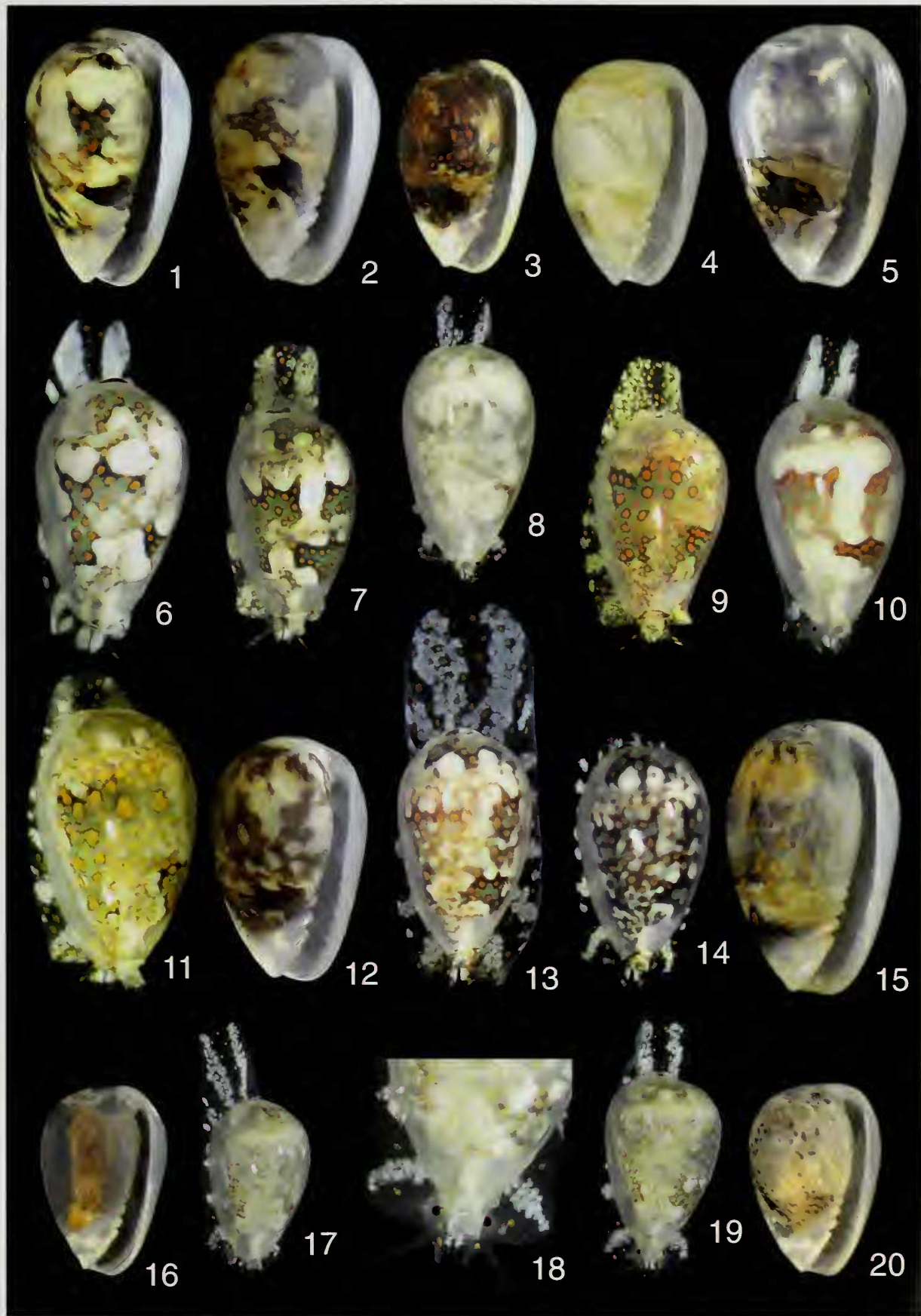
11, 15. *Gibberula ubitalta* n. sp., off Chichime Cays, San Blas, Panama, 2.50 x 1.60 mm, W:L 64%, holotype MNHN 20978.

12-14. *Gibberula farlensis* n. sp., Farl's Bogue, Belize.

12, 14. 2.26 x 1.47 mm, W:L 65%, holotype MNHN 20976; **13.** 2.37 x 1.50 mm, W:L 63%, paratype 2, AWC.

16-20. *Gibberula macula* n. sp.

16-17. East Holandes Cays, San Blas, Panama, 20 m, 1.77 x 1.19 mm, W:L 67%, holotype MNHN 20982; **18.** Head enlargement, Lemon Cays, San Blas, Panama, 20 m, 1.75 x 1.14 mm, W:L 64%; **19, 20.** Lemon Cays, San Blas, Panama, 20 m, 1.76 x 1.17 mm, W:L 66%.



Habitat. Brownish muddy grit at 73-75 metres depth.

Remarks. *Gibberula ubitalta* n. sp. is closest to *G. ubitaensis* Espinosa and Ortea, 2000, with which it is compared. There is no significant difference in shell morphology except that average size of *G. ubitalta* n. sp. is a little longer. The largest specimen collected, designated Paratype 5, is a juvenile shell and is 0.2 mm longer than the largest known example of *G. ubitaensis*. Chromatism is significantly different, the orange marks being irregularly shaped and much larger than the round orange spots of *G. ubitaensis*, the pattern is less distinct and general appearance more orange. *G. ubitalta* n. sp was dredged from 73-75 metres whereas *G. ubitaensis* is limited to depths of less than 30 metres. Extensive dredging was carried out off the coast of Panama between Bocas del Toro and Playon Chica, San Blas, but much of this very large area was not sampled. Only one lot of *G. ubitalta* n. sp was found, and considerably more sampling is necessary to establish if *G. ubitalta* n. sp is endemic to the type locality.

Etymology. The name is taken from *G. ubitaensis* and the Latin *altus*, an adjective for deep.

***Gibberula crassa* n. sp.**

Figs. 21-35, 56-68

Type material. Off Chichime Cays, San Blas, Panama, 9°37.3'N 78°52.4'W, 85 m.

Holotype. 1.77 x 1.33 mm, W:L 75%, ad. lv., MNHN 20980; Paratype 1. 1.77 x 1.29 mm, W:L 73%, ad. dd., MNHN 20981; Paratype 2. 1.79 x 1.30 mm, W:L 73%, ad. lv., AWC; Paratype 3. 2.01 x 1.44 mm, W:L

72%, ad. dd., TMC; Paratype 4. 1.81 x 1.32 mm, W:L 73%, ad. lv., TMC; Paratype 5. 1.64 x 1.21 mm, W:L 74%, ad. dd., AWC.

Other material. 1 ad. lv., 60 ad. dd., off Isla Escudo de Veraguas, Panama, 9°06'N 81°33.5'W, 70 m; 2 ad. lv., 6 juv. lv., 3 ad. dd., off Linton, Panama, 9°41'N 079°38'W 41 m; 9 ad. dd., off Linton, Panama, 9°42.3'N 079°40.5'W, 95 m; 80 ad. dd., off Escribaños reefs, Panama, 9°39.4'N 79°09.7'W, 80 m; 4 ad. lv., 40 ad. dd., off Chichime Cays, San Blas, Panama, 9°37'N 78°52'W, 73-75 m; 9 ad. dd., off Chichime Cays, San Blas, Panama, 9°37.3'N 78°53.2'W, 75 m; 90 ad. dd., off San Blas, Panama, 9°34.9'N 78°38.6'W, 62 m and 72 m; 70 ad. dd., off San Blas, Panama, 9°38'N 78°50'W, 50 m; 4 ad. lv., 3 juv. lv., 40 ad. dd., off San Blas, Panama, 9°37'N 78°50'W, 72-75 m; 50 ad. dd., off Playon Chica, San Blas, Panama, 9°23.0'N 78°09.5'W, 74 m; 15 ad. dd., Salmedina reefs, off Cartagena, Colombia, 10°23'N 75°39'W, 41 m.

Type locality. Off Chichime Cays, San Blas, Panama, 9°37.3'N 78°52.4'W, 73-75 m (Map ref. 9).

Description. Shell smooth, glossy, semi-transparent, sub-triangular, size range 1.64 x 1.21 mm to 2.01 x 1.44 mm, W:L 72-75%, spire almost flat, callused over. Protoconch transparent, not visible beneath transparent callus. Teleoconch suture less than one revolution, plainly visible, commencing close to protoconch, drops down slightly anteriorly, progresses horizontally for more than half revolution, extends outwards over preceding whorl, final quarter of revolution sweeps up strongly to very high labial insertion point. Transparent callus extends from posterior notch covering much of spire.

Figures 21-40

21-35. *Gibberula crassa* n. sp.

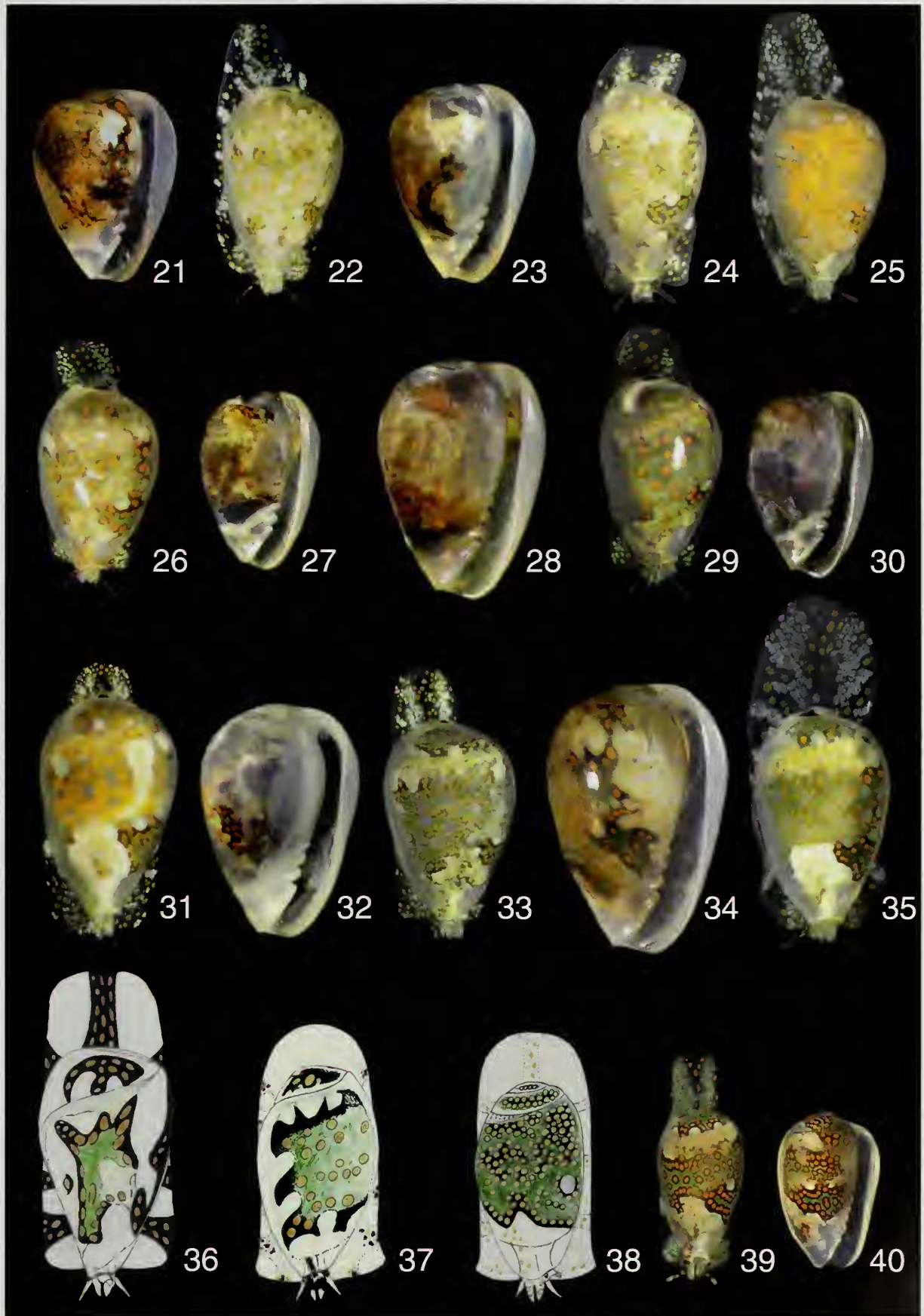
21-22. Holotype, off Chichime Cays, San Blas, Panama, 87 m, 1.77 x 1.33 mm, W:L 75%, MNHN 20980; **23.** Paratype 4, off Chichime Cays, San Blas, Panama, 87 m, 1.81 x 1.32 mm, W:L 73%; **24.** Live animal, off Chichime Cays, San Blas, Panama, 75 m, 2.12 mm; **25.** Variation of chromatism, off Chichime Cays, San Blas, Panama, 85 m, 1.88 mm; **26.** Live animal, off Linton, Panama, 41 m, 1.64 mm; **27.** Smallest specimen, off Linton, Panama, 41 m, 1.66 x 1.12 mm, W:L 68%; **28.** Specimen, off Linton, Panama, 41 m, 2.20 x 1.76 mm, W:L 70%; **29.** Variation of chromatism, off Linton, Panama, 41 m, 1.65 mm; **30.** Specimen, off Linton, Panama, 41 m, 1.73 x 1.20 mm, W:L 69%; **31.** Variation of chromatism, off Chichime Cays, Panama, 85 m, 2.1 mm; **32-33.** Specimen, off Chichime Cays, Panama, 88 m, 2.12 x 1.46 mm, W:L 69%; **34-35.** Specimen, off N. E. Isla Escudo de Veraguas, Panama, 63 m, 2.42 x 1.65 mm, W:L 68%, (Animal image, mag. X15).

36. *Gibberula ubitaensis* Espinosa & Ortea, 2000, Punta Ubita, Costa Rica, 12-15 m, 2.35 x 1.6 mm, W:L 68%, (Avicennia, 2000, nos. 12-13, p. 104).

37. *Gibberula sierrai* Espinosa & Ortea, 2000, Punta Ubita, Costa Rica, 10-15 m, 2.0 x 1.4 mm, W:L 72%, (Avicennia, 2000, nos. 12-13, p. 104).

38. *Gibberula bribri* Espinosa & Ortea, 2000, Punta Ubita, Costa Rica 10-15 m, 1.85 x 1.2 mm, W:L 65%, (Avicennia, 2000, nos. 12-13, p. 104).

39-40. *G. bribri* Espinosa & Ortea, 2000, Isla Linton, Panama, 10-15 m, 1.44 x 0.92 mm W:L 64%, collected by author.



Lip slightly curved, moderately thickened, raised posteriorly, posterior half strongly curled inwards, turns through approximately 80 degrees to form strong shoulder, slightly flared anteriorly, 9 labial denticles and lirae fill slightly more than half, strong medially, weaker anteriorly, weakest on flare, posterior notch weak. Three strong columellar plications and one lirae fill half of aperture, second and third short. Anterior callus moderately strong at distal ends of all plications. Strong parietal callus ridge present, extends over plications causing slight excavation on all except first. Aperture moderately wide, curves very strongly inwards posteriorly and widens, widening more so anteriorly. Animal: Foot approximately 50% longer, slightly wider than shell, semi-transparent with numerous weak, white marks laterally, close to edge of foot, anterior marks larger, and two diffuse posterior marks larger (foot of holotype is damaged), all intermingled and interspersed with small round orange, green and occasional black spots. Lobes of semi-transparent split head with white marks medially, one or two orange spots laterally. Tentacles semi-transparent with one orange mark. Eyes black with faint greyish annular rings. Siphon short, unusually thick, semi-transparent, partially covered with approximately equal number of small whitish and orange spots. Mantle roof comprised of somewhat variegated yellowish-white background, several small darker marks of bright orange spots intermingled with green spots and small black marks, two located anteriorly in right and left quarters, four located posterior medially forming a broken band extending across mantle roof. Below this band several pale greyish marks with a few orange spots are located. Two paler yellowish white marks are located adjacent to the left and right sides of the mark located in posterior right quarter. Three semi-circular yellowish white marks are located immediately above the suture, otherwise this area bears similar chromatism to mantle roof.

Distribution. Known to range from off Isla Escudo de Veraguas, Panama, to off Cartagena, Colombia.

Habitat. Blackish or brownish muddy grit at 41 to 95 metres depth, otherwise unknown.

Remarks. *Gibberula crassa* n. sp. is closest to *Gibberula ubitaensis* Espinosa and Ortea, 2000, *Gibberula ubitalta* n. sp., and *Gibberula macula* n. sp. Compared to *G. ubitaensis*, *G. crassa* is smaller and more inflated with W:L 72-75% compared to typical W:L 64-68% in *G. ubitaensis*. The point of maximum shell width is higher, and the aperture curves inwards posteriorly more strongly, columellar plications are usually slightly excavated. Chromatism of *G. crassa* (Figs. 21-25) is more variegated with the pattern being barely discernable and hue being more orange than *G.*

ubitaensis (Figs. 6-10), except for samples of *G. ubitaensis* found in brownish water amongst mangroves (Fig. 9). *G. crassa* was dredged in depths from 41 m to 95 m, whereas *G. ubitaensis* is a shallow water species, down to approximately 25 metres. *G. ubitalta* is also a deep water species from depths of 73-75 m, with shell morphology very similar to *G. ubitaensis* except for its larger size and much lower inflation at W:L 61-65%. Chromatism of *G. ubitalta*, although also tending towards orange, is distinguished from *G. crassa* by the distinctive irregular shaped orange marks. *G. macula* has a somewhat similar shell morphology to *G. crassa*, but is a shallow water species, a sand or mud dweller, and its pale chromatism includes many small black spots which are absent in *G. crassa*.

Gibberula crassa n. sp. is a very common species throughout its range, but most shells were collected dead. A large lot from off Chichime Cays, San Blas, dredged at 85 metres did include a number of live animals and was chosen as type species (Figs. 21 to 25). A lot from off Isla Linton, dredged at 41 metres, almost identical to the type species, also included a number of live specimens (Figs. 25-30). A further large lot was collected off Chichime Cays at 73-75 metres, half mile to north of the type locality, containing four live specimens of intermediate size (Figs. 31-33), and a large lot found north east of Isla Escudo de Veraguas at 70 metres, the most westerly location known for this species contained one live specimen (Figs. 34-35, 60). This was the largest live specimen found, with size 2.42 x 1.65 mm, W:L 68%, and differs from the type species in its higher shoulder and chromatism which shows more white, but these variations are considered insufficient to justify specific status. Further east, off Playon Chica, San Blas, many shells were collected at 74 metres depth, size range 1.65 x 1.22 mm to 2.00 x 1.33 mm, W:L 72-74%, but no live specimens were found. This lot has very similar shell morphology to the type species (Figs. 61-62). The most easterly material was collected close to Salmedina reefs, off Cartagena, Colombia, at 41 metres depth. Sizes of 15 shells range from 1.75 x 1.20 mm to 2.22 x 1.52 mm, W:L 67-69% (Figs. 65-68). In several of the shells in this lot the protoconch can be seen (Figs. 65,68). This is unusual and may indicate that another species is present, but in the absence of live animals this cannot be confirmed. The most pointed shells were collected off Escribaños reefs, Panama, approximately 25 miles west of the type locality at 80-90 metres (Figs. 63-64), but no live specimens were found. Size range is 1.85 x 1.23 mm to 2.23 x 1.56 mm, W:L 69-71%. Many other single shells and small lots were collected throughout the range and some live animals were included, but they were all juvenile specimens. Images of the spire of *G. crassa* clearly show the diagnostic features of *Gibberula ubitaensis* species group (Figs. 56-59, 61-68), therefore, *G. crassa* is assigned to *G. ubitaensis* species group, Section B.

Etymology. The name refers to the coarse or strong columellar plications and strong labial denticles: the Latin word for coarse is *crassus*.

***Gibberula macula* n. sp.**

Figs. 16 to 20, 54-55

Type material. Holotype. 1.77 x 1.19 mm, W:L 67%, ad. lv., MNHN 20982; Paratype 1. 1.78 x 1.20 mm, W:L 67%, ad. lv., MNHN 20983; Paratype 2. 1.74 x 1.19 mm, W:L 68%, ad. lv., TMC; Paratype 3. 1.78 x 1.18 mm, W:L 66%, ad. lv., AWC; Paratype 4. 1.66 x 1.12 mm, W:L 67%, ad. lv., AWC; Paratype 5. 1.78 x 1.14 mm, W:L 64%, ad. lv., TMC.

Other material. 21 ad. lv., 5 juv. lv., east Holandes Cays, San Blas, Panama; 20 ad. lv., 3 juv. lv., Lemon Cays, San Blas, Panama; 2 ad. lv., 1 juv. lv., Snug Harbour, Playon Chica, San Blas, Panama; 1 ad. lv., Isla Linton, Panama.

Type locality. East Holandes Cays, San Blas, Panama, approximately 9°35' N 078°40' W (Map ref. 9).

Description: Shell smooth, glossy, semi-transparent, obovate, size range 1.66 x 1.12 mm to 1.78 x 1.20 mm, W:L 64-67%, spire very low, apex rounded, callused over, transparent. Protoconch embedded, invisible. Teleoconch suture slightly less than one turn, visible beneath callus, emerges from protoconch, drops down abruptly anteriorly, progresses horizontally for half revolution, drops down anteriorly over preceding whorl for further quarter revolution before sweeping up to insertion point, callused over. Lip slightly curved and thickened, curled inwards posteriorly, slightly flared anteriorly, 8 weak labial denticles almost fill anterior half, posterior notch weak but wide, shoulder weak. Three columellar plications and two lirae fill half of aperture. First and second strong, third weak, lirae very weak. Anterior callus strong at distal ends of first and second plication, weaker at third. Moderate parietal callus ridge present. Aperture moderately wide, curls inwards strongly posteriorly, widens slightly anteriorly. Animal: foot approximately 50% longer, slightly wider than shell, semi-transparent, 5 white marks laterally, one or two minute orange spots between, two stronger white marks extend posteriorly with five small orange spots between, white marks do not extend to edge of foot. Lobes of semi-transparent split head with small white marks medially, 2 adjacent orange spots, unmarked area along lateral edges. Tentacles thin, semi-transparent, unmarked. Eyes black on translucent white area of head, white mark touching outer edge. Siphon short and thick, translucent white with faint, dull white marks (Fig. 18). Mantle roof: Generally pale with off-white background and variegated with green, orange, grey and black. Slightly brighter orange, green and black spots on grey background form a noticeable mark on

right side, with two roundish white marks adjacent. Similar brighter marks form a noticeable mark medially on left side. A pale band is located immediately anterior to suture. Similar chromatism extends above suture.

Distribution. Known from three locations in San Blas: Lemon Cays, east Holandes Cays and Playon Chica, and a sandy area adjacent to rocks immediately west of Isla Linton, Panama.

Habitat. Open areas of muddy sand at depths of around 15 to 20 metres

Remarks. *G. macula* n. sp. is closest to *G. crassa* n. sp. with which it is compared. It is less pointed, and less inflated and with W:L 64-67% compared to W:L 72-75% in *G. crassa*, otherwise differences in shell morphology are not significant. It is mainly distinguished by its very different chromatism, appearing paler, more variegated, and more finely spotted with barely perceptible pattern. It is a sand and mud dwelling species and was only found in depths of around 15-20 metres. An enlarged image shows head with medial split opened (Fig. 18). Spire and suture (Figs. 54, 55) clearly show diagnostic features of *G. ubitaensis* species group, therefore, *G. macula* n. sp. is placed in Section B.

Etymology. The name refers to the spotty appearance, the Latin for spot being *macula*.

***Gibberula ubitaensis* species group**

Introduction. Species belonging to *Gibberula ubitaensis* species group (Figs. 41-43, 45-48, 53-68) are only found in the western Caribbean and are distinguished by their very distinctive spire and suture which are diagnostic. All have very high labial insertion, but this is not a diagnostic feature of the group.

G. ubitaensis species group can be divided into two sections: Section A, species which are very closely related to *G. ubitaensis*, and Section B, species which have somewhat different shell morphology and are less closely related to *G. ubitaensis*, but embody diagnostic features which distinguish this group from all other Caribbean *Gibberula*.

Section A. Species closely related to *G. ubitaensis* Espinosa and Ortea, 2000:

G. ubitaensis Espinosa & Ortea, 2000, Punta Ubita, Manzanillo, Costa Rica.

G. hiramii Espinosa & Ortea, 2007, Quiebra Hacha, La Habana, Cuba.

G. baisrei Espinosa & Ortea, 2007, Quiebra Hacha, La Habana, Cuba.

G. farlensis n. sp., Farl's Bogue, Belize.

G. ubitalta n. sp., off Chichime Cays, San Blas, Panama.

Section B. Other species which embody diagnostic features of the group:

G. sierrai Espinosa & Ortea, 2000, Punta Mona, Manzanillo, Costa Rica.

G. olivai Espinosa & Ortea, 2005, Pinar del Rio, Cuba. (tentative assignment).

G. crassa n. sp., off Chichime Cays, San Blas, Panama.

G. macula n. sp., east Holandes Cays, San Blas, Panama.

Diagnostic features. Morphology of the generally rounded spire, in particular protoconch and teleoconch, is diagnostic of *Gibberula ubitaensis* species group. The entire teleoconch suture is generally visible and slightly less than one revolution in extent (Figs. 41-43, 45-48, 53-60, 61, 64, 65, 68). It emerges from the protoconch, which is rarely visible, drops down abruptly anteriorly (Fig. 41), progresses horizontally for approximately half a revolution, drops down anteriorly over preceding whorl for further quarter revolution before sweeping up to final insertion point. After approximately three quarters of a revolution the suture widens, both internal and external edges being visible. The internal edge is the insertion point and curves outwards and anteriorly over preceding whorl (Fig. 42). The external edge is formed by subsequent callus deposit and curls inwards and posteriorly towards the protoconch, gradually widening from the internal edge. Callus deposit around weak posterior notch covers imbedded protoconch and varies considerably, frequently being very heavy, occasionally forming a strong apex (Fig. 1). Protoconch is transparent, always heavily covered with transparent callus which generally renders it unidentifiable, seldom being visible externally even with high magnification. When examined internally, faint outlines of protoconch whorls can be seen, even when complete re-absorption has taken place (Fig. 47-48).

Distribution. *Gibberula ubitaensis* species group has a known range extending from Salmedina reefs off Cartagena, Colombia, westwards through Islas Rosario and Islas Bernardo, Colombia; Panama; Costa Rica; the off-shore islands San Andres and Providencia, Colombia; not recorded in Nicaragua, but probably present; Honduras; Belize, and Cuba. It seems unlikely that the range will be extended eastwards as sampling has been carried out in the adjoining area with negative results, but it is possible that northern and north eastern limits could be extended as only limited sampling has been carried out at this end of the range. *G. ubitaensis* species group appears to be absent from Aruba, Curaçao, Bonaire and Venezuela in the south, Puerto Rico, Florida and Bahamas in the north, and all Caribbean islands further east.

Habitat. *Gibberula ubitaensis* species group has been found in a wide range of substrates and depths down to approximately 100 metres. *Gibberula ubitaensis* Espinosa and Ortea, 2000, sensu stricto, is restricted to weed, algae, sand, or mud-covered surface areas of rocks and rubble in depths down to approximately 25 metres. It does not appear to inhabit open areas of sand or mud. Species within the group which were dredged from depths greater than approximately 30 metres are presumed to be sand or mud dwellers due to the absence of rubble brought up in the dredge. Only *G. macula* n. sp., east Holandes Cays, San Blas, Panama, was clearly found to be a sand or mud dweller in depths ranging from 15-20 metres.

Comments. *Gibberula ubitaensis* Espinosa and Ortea, 2000, sensu stricto, is found from Colombia to Belize, a range of approximately 900 miles. Specimens which most closely match *G. ubitaensis* type species were collected in shallow, protected, clean water at Escudo de Veraguas, Panama (Figs. 1, 6). These specimens exhibit very high labial insertion with heavy surrounding callus, and chromatism with contrasting colours and clearly defined pattern. *G. ubitaensis* exhibits wide intra-population and inter-population variations in shell morphology and animal chromatism across the whole distribution range.

Figures 41-60

41-43, 45, 47-48. *Gibberula ubitaensis* Espinosa & Ortea, 2000.

41-42. Specimen, San Andres, Colombia; 43. Isla Linton, Panama; 45. Isla Caribaru, Islas Rosario, Colombia;

47-48. Snug Harbour, San Blas, Panama.

44. *Gibberula* species, undescribed, Malmok, Aruba, 6 m, 1.76 x 1.08 mm, showing suture of 2 3/4 turns.

46. *Gibberula farlensis* n. sp., Farl's Bogue, Belize.

49-52. *Gibberula granulinaformis* McCleery, 2008, off Islas Los Testigos, Venezuela, 73 m.

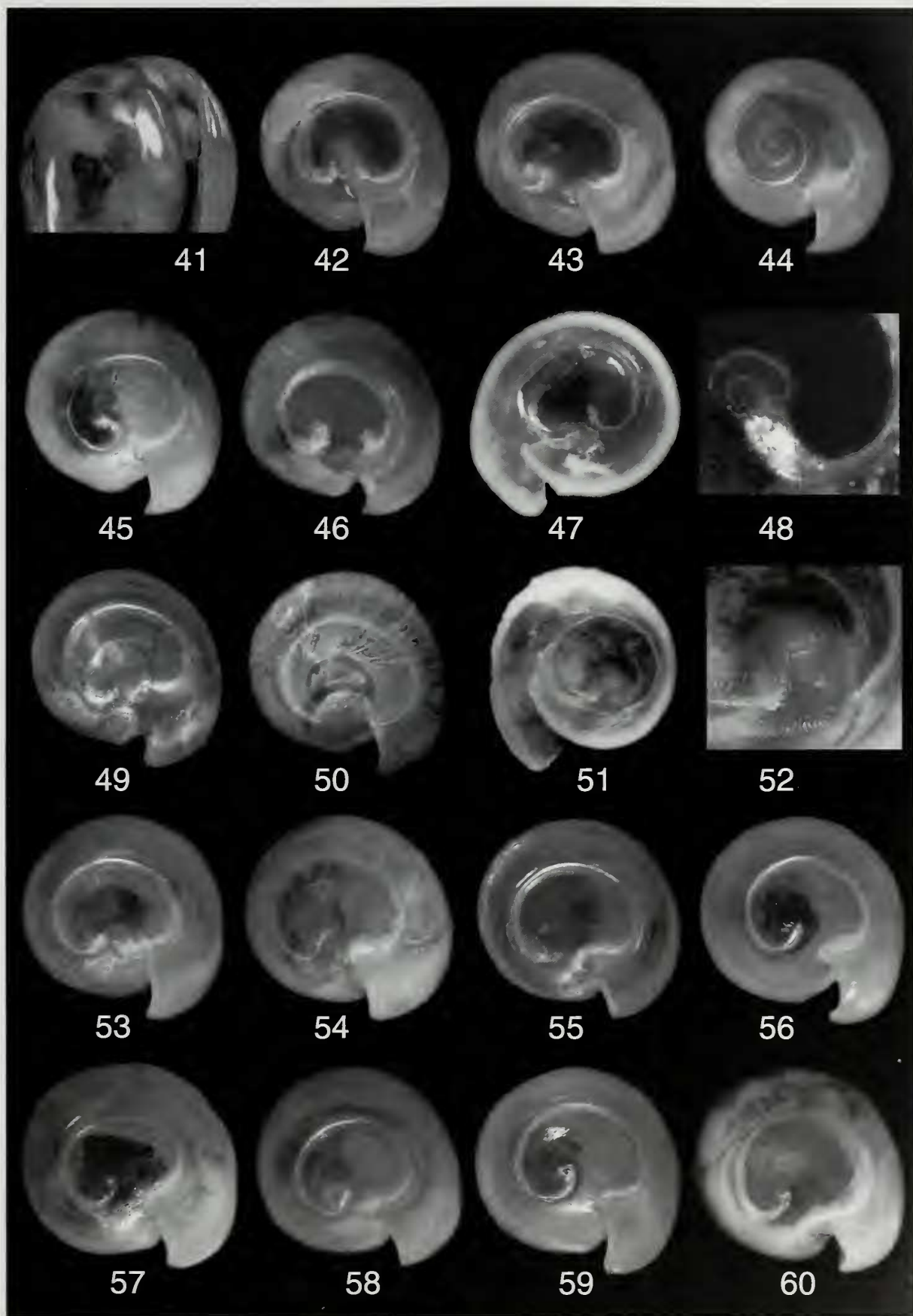
53. *Gibberula ubitalta* n. sp., off Chichime Cays, San Blas, Panama.

54-55. *Gibberula macula* n. sp., east Holandes Cays, San Blas, Panama.

56-60. *Gibberula crassa* n. sp.

56. Specimen, off Chichime Cays, San Blas, Panama; 57. Specimen, off Linton, Panama, 41m; 58-59.

Specimens, off Chichime Cays, San Blas, Panama; 60. Specimen, Isla Escudo de Veraguas, Panama.



Specimens with strongest columellar plications and heavy, inflated shells were found in rubble in shallow water with strong wave action in Isla Providencia, Colombia (Fig. 2). Small specimens with size range 1.49 x 0.98 mm to 2.05 x 1.32 mm, W:L 65-66%, with typical plications and labial denticles, and light callus, were found amongst muddy rubble in shallow water with little wave action along the north shore in Portabello Bay, Panama (Fig. 3). At Islas Rosario, where the tidal currents were strong, but wave action was slight, inflated shells with typical columellar plications, very weak labial denticles and light callus were collected in several locations in shallow water amongst rubble (Fig. 4). Specimens with strongest labial denticulation came from a reef in the centre of Sandfly Bay, Bocas del Toro, Panama, where wave action is moderately strong at times (Fig. 5). Darkest chromatism with sharply defined pattern was found in specimens from Playa Damas, Panama. The location was in channels amongst mangroves, in muddy rubble, in gently flowing water coming from the nearby vital reef (Fig. 7). Palest chromatism was found at Islas Rosario and Islas Bernardo, Colombia (Fig. 4, 8), and also in Belize and Honduras. Samples collected in mangrove areas where the water is very still tend to be more densely covered with orange spots and often show a yellowish hue. Such specimens were collected in 2-6 metres, in dead coral amongst an abundance of sponges, where the water was still and brownish coloured, in a small mangrove lagoon, Neloguichi, San Blas, Panama (Fig. 9). A colony with unusual reddish colour was collected in shallow water in clean sandy rubble inside the vital reef, where there was continual current and moderate wave action, San Andres, Colombia (Fig. 10), and a single similar specimen was found amongst a population with otherwise typical chromatism, on shallow, "rubble covered" reef flats at Lighthouse Reef, Belize.

Amongst the many *Gibberula* species from Costa Rica

and Cuba which have been described by Espinosa and Ortea in recent years, (Avicennia, 2000), (Avicennia, 2005), and (Avicennia 2007), are four which need to be considered for placement in *Gibberula ubitaensis* species group.

Gibberula sierrai Espinosa & Ortea, 2000, Punta Mona, Manzanillo, Costa Rica, (Avicennia, 2000, no12-13, p. 99), (Fig. 37). The original description and accompanying figures show the diagnostic features of *G. ubitaensis* species group, but other features indicate this species is not very closely related to *G. ubitaensis*: It was described as having a W:L ratio of 72% which is considerably more inflated, and there is more black in the chromatism, the head being described as black, which is unusual amongst Caribbean *Gibberula*. In the discussion it was stated "*G. sierrai* closely resembles *Gibberula bribri* Espinosa and Ortea, 2000, which is smaller and has an almost flat apex, raised lip close to the shoulder, and only five columellar plications. Also, *G. bribri* has a more elaborate colour pattern in spite of being smaller". (Fig. 38). *G. bribri*, was collected at Isla Linton, Panama, by the author (Figs. 39-40), and does not have the diagnostic features of *G. ubitaensis* species group. Therefore, it is concluded that *G. sierrai* is not very closely related to *G. ubitaensis*, but it does have the diagnostic features of *G. ubitaensis* species group, Section B, to which it is assigned.

Gibberula olivai Espinosa & Ortea, 2005, Pinar del Rio, Cuba, (Avicennia, 2005, no. 18, pages 38, 42), (Figs. 71-72), looks very similar to *G. ubitaensis* and need only be compared with it. An unusually high labial shoulder and the described relatively wide postlabial varix rule out assignment to *G. ubitaensis* species group, Section A. The protoconch was described as being callused over, and a dorsal image (Fig. 72) shows the diagnostic suture of the group, but the postlabial varix is problematical. Therefore, *G. olivai* is only tentatively assigned to *G. ubitaensis* species group, Section B.

Figures 61-76

61-68. *Gibberula crassa* n. sp.

61. Shell, off Playon Chica, San Blas, Panama, 74 m, 1.76 x 1.27 mm, W:L 73%; **62.** Shell, off Playon Chica, San Blas, Panama, 74 m, 1.70 x 1.25 mm, W:L 74%; **63-64.** Shell, off Escribaños reefs, Panama, 80 m, 1.92 x 1.35 mm, W:L 70%; **65-66.** Shell, off Salmedina reefs, off Cartagena, Colombia, 62 m, 1.75 x 1.20 mm, W:L 69%. Unusually well defined protoconch; **67-68.** Shell, off Salmedina reefs, off Cartagena, Colombia, 62 m, 1.85 x 1.28 mm, W:L 69%. Unusually well defined protoconch.

69-70. *Gibberula bribri* Espinosa & Ortea, 2000, Isla Linton, Panama. Specimen showing sutures of 1 $\frac{3}{4}$ revolutions. Not belonging to *Gibberula ubitaensis* species group.

71-72. *Gibberula olivai* Espinosa & Ortea, 2005, Pinar del Rio, Cuba, 25-30 m, 2.5 x 1.7 mm, W:L 67%, (Avicennia, 2005, no. 18, p. 38, fig. 311).

73-74. *Gibberula hirma* Espinosa & Ortea, 2007, Quiebra Hacha, La Habana, Cuba, littoral, 2.6 x 1.7 mm, W:L 65%, (Avicennia, 2007, no. 19, p. 119, pl. 4).

75-76. *Gibberula baisrei* Espinosa & Ortea, 2007, Quiebra Hacha, La Habana, Cuba, 18-23 m, 2.55 x 1.58 mm, W:L 62%, (Avicennia, 2007, no. 19, p. 119, pl. 4).



Gibberula hiram Espinosa & Ortea, 2007 (Avicennia, no. 19, p 119), (Figs. 73-74), appears identical to *G. ubitaensis*, but the description states there are two teleoconch revolutions. A close examination of the suture (Fig. 74), shows one suture revolution, split in the final part of the revolution, as per *G. ubitaensis* species group diagnosis. It seems probable that the split suture has been mistakenly described as two revolutions. Therefore, *G. hiram*, is assigned to *G. ubitaensis* species group, Section A.

Gibberula baisrei Espinosa & Ortea, 2007 (Avicennia, no. 19, p 119), (Figs. 75 & 76), appears to be very similar to *G. ubitaensis*, well within the limits of variations found in this species. The teleoconch suture is described as having one revolution which can be clearly seen in the figured image. There are no features described which indicate that this species is not very closely related to *G. ubitaensis*. Therefore, it is assigned to *G. ubitaensis* species group, Section A.

Only one eastern Caribbean species with very high labial insertion has been described, *Gibberula granulinaformis* McCleery, 2008 (Figs. 49-52).

This species has similarities with species in *G. ubitaensis* species group: very high labial insertion and shoulder, teleoconch suture of less than one revolution and protoconch totally immersed in transparent callus. Otherwise morphology of spire and suture are distinctly different. Protoconch suture appears to grow outwards from the nucleus before it transforms into teleoconch suture (Figs. 51, 52). Callus which defines the external (posterior) edge of teleoconch suture is much less extensive and the apparent split between internal and external edges occurs later in the single, partial revolution of teleoconch suture. Callus wash which extends posteriorly above the weak posterior notch is slightly textured and is outlined by a smooth edge which shows clearly in dead shells (Figs. 49, 50). A further very light callus wash extends over the posterior part of the shell and can occasionally be striate (Fig. 50), terminating posteriorly in a distinct circular ridge close to the apex (Figs 49-50). These features show the spire morphology to differ from that of *G. ubitaensis* species group. *G. granulinaformis* was described from Islas Testigos, Venezuela, but shells with similar morphology were collected in the area between Islas Tortugas, Venezuela, and Tobago, Trinidad and Tobago, in depths from 60 to 95 metres. Live animals were only collected in Islas Testigos, and it has not been possible to determine if more than one species exists. Therefore, all these samples are regarded as *G. granulinaformis*. This species clearly does not belong to *G. ubitaensis* species group.

The diagnostic spire and suture of all species assigned to *G. ubitaensis* species group, Sections A and B, have a very constant morphology and are very different from those of any other described Caribbean *Gibberula* species. *G. bibr* (Figs. 69-70), and an undescribed species from Malmok, Aruba (Fig. 44), are illustrated, and have spire and suture representative of the majority of Caribbean *gibberula*. The considerable inter-population variability of *G. ubitaensis* Espinosa & Ortea, 2000, across its geographical range has been demonstrated, and it is very possible that further research, using latest diagnostic techniques, could reveal the existence of other distinct species.

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